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A CONTRIBUTION TO THE MOSS FLORA OF ORULGAN RANGE (YAKUTIA)

МАТЕРИАЛЫ К ФЛОРЕ МХОВ ХРЕБТА ОРУЛГАН (ЯКУТИЯ)

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Abstract

Moss flora of the Orulgan Mountain Range in Yakutia is studied on the material of the expedition of 2011, which crossed the Range at 67–68° North. The area comprises northern taiga combined with tundro-steppe areas and mountain tundra vegetation. 241 moss species are revealed including some rare xerophytes, *Indusiella thianschanica, Entosthodon pulchellus, Bryoerythrophyllum latinervium,* and *Didymodon johansenii*. Other rare and interesting findings include *Orthotrichum holmenii, Meesia hexasticha* and *Lyellia aspera*. However, many arctic species which had been expected to be found were not collected. Regardless of the moderate overall diversity, the area is interesting in a prevailing specific mire type with *Scorpidium scorpioides* as a dominant, and at places nearly the only moss species.

Резюме

Приводятся данные по флоре мхов хребта Орулган (Якутия, Верхоянская горная система), собранные в результате эспедиции 2011 г., пересекшей хребет в долготном направлении на 67–68° северной широты. Изученная территория занята северной тайгой, чередующейся с участками тундростепной растительнсоти и горными тундрами. Был выявлен 241 вид мхов, в том числе некоторые редкие ксерофитные виды: *Indusiella thianschanica, Entosthodon pulchellus, Bryoerythrophyllum latinervium* и *Didymodon johansenii*. Среди других интересных находок можно отметить *Orthotrichum holmenii, Meesia hexasticha* и *Lyellia aspera*. В то же время многие ожидаемые в этом регионе арктические виды найдены не были. Несмотря на сравнительно небольшое разнообразие мхов, изученная территория интересна тем, что здесь представлен особый тип болот, на которых доминирует *Scorpidium scorpioides,* местами практически единственный вид мхов.

KEYWORDS: Orulgan, bryophyte flora, tundro-steppe, minerotrophic mires

INTRODUCTION

The Orulgan Mountain Range is an extensive area and at the same time one of the regions in Russia with very poorly explored moss flora. This fact corresponds to its rather remote position, lack of roads and severe climate, causing low population, mainly reindeer farmers.

Being one of nine parts of the Verkhoyansky Mountain System, extended along the right bank of the Lena River in Yakutia (Fig. 1), the Orulgan Mountain Range is one of its largest and highest parts, stretching in north-south direction within 64-69°N, for more than 500 km, being 150-170 km wide (Atlasov, 1938; Rusanov et al., 1967). Its watershed is 150-200 km east from the Lena River, being separated from the valley by a plain 70-100 km wide. The maximal elevation of the range is 2409 m, while most ridges reach 1500-1700 m in its cental part and 800-900 m closer to perifery. In the central part of the ridge in the study area, the upper course of the Tumara River (point 10 in Fig. 1), the valley becomes plateau-like, represented by flat area of 5-7 km in between ridges, at the elevation 1100-1300 m (Figs. 10-11).

West- and east-faced macroslopes are quite different, as the latter is more gentle and has hilly relief, making the whole territory strongly affected by cold winds from the Arctic Ocean and from Eastern Yakutia known as the coldest area in the Nothern Hemisphere with absolute minimum temperature –72°C. Rock outcropes, mostly Permo-Triassic aleurolites, are quite scattered in the east-facing slope (Figs. 2-9).

Contrary to this, the west-facing slope to the Lena River has deep valleys, with cayons and numerous rock outcrops, providing a diversity of habitats, although bedrocks are mostly schists, which easily fall to thin plates, thus making outcrops rather unstable (Figs. 18-22).

Climate of the area is sharply continental. The non-frost period is 50-70 days, mean temperature in July is +12°C, in January –38°C. Snow is 30-40 cm thick and melts usually in the second half of May. Annual precipi-

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Table 1. Collecting localities in Orulgan Range

№	Locality	alt, m	Lat	Long
1	5 km E of Sakkyryr Settlement, valley of Ulakhan-Sakkyryr River	450	67°46’	130°27’
2	2-3 km SW of Sakkyryr Settlement	470	67°46.5’	130°20’
3	W edge of Sakkyryr Settlement	500	67°48’	130°23’
4	Dyaballakh Creek	670-780	67°55’	130°05’
4a	between Dyaballakh Creek and Tumara River	800	67°58’	130°50’
5	Dyaballakh Creek, upper course	780-850	67°56’	129°52’
6	unnamed tributary of Tumara River upstream from permanent valley ice-field ‘Tumara-Taryna’	800	68°00’	129°45’
7	left slope to Dzhelon Creek Valley near confluence with Tumara River	800-850	68°07’	129°32’
8	right slope to Dzhelon Creek Valley 3 km from confluence with Tumara River	800-1000	68°07’	129°32’
9	Dzhelon Creek, upper course	1100	68°14’	128°50’
10	Tumara River, upper course	1200	68°16’	128°46’
11	Tumara River, upper course, Sakhchan stream	1300	68°17’	128°47’
12	Tumara River, upper course, near Kovsh Glacier	1350-1750	68°14’	128°38’
12a	pass from Tumara River valley to Aenigan-Tolonoo Creek valley	1300	68°17’	128°27’
13	Aenigan-Tolonoo Creek, upper course	800	68°16’	128°25’
14	Aenigan-Tolonoo Creek, left tributary	650	68°14’	128°06’
15	Aenigan-Tolonoo Creek, valley and right slope to valley	600-800	68°14’	128°06’

tation is 150-200 mm, while relative humidity is usually 50-60% (Izyumenko, 1968). However, microclimate variation is great: on the west-facing slope, in canyon sheltered from wind at 850 m elev. (point 13, Fig. 1), we faced day temperature +35°C, while 15 km apart, at 1200 m (points 10 and 11 in Fig. 1) it does not exceed +10°C, dropping almost to zero at night.

Main Vegetation Types

Forests are formed mostly by *Larix cajanderi*, and only flood-valley forests on the Lena River macroslope have stands also of *Chosenia arbutifolia.*

Larix forms a continuous forest at 450 to 800 m alt. in the study area, while above, up to 900(-1000) m, only small scattered stands occur. Even at elevations of 600-900 m, extended territories are covered by polygonal bogs, surrounded by meadows and tundra-like vegetation. South-facing slopes are covered by so-called tundro-steppes.

Larix forests are commonly rather dry, with scattered shrublets, lichen carpet and at places with *Aulacomnium turgidum, Hylocomium splendens* var. *obtusifolium, Rhytidium rugosum* and *Dicranum elongatum*, somewhat more rare are *Pleurozium schreberi* and *Ptilium crista-castrensis*. Depressions, as well as slopes in forest are wetter, and moss cover is better developed, with *Tomentypnum nitens, Sphagnum spp.* and *Aulacomnium palustre*.

Numerous peatlands at lower elevations are mainly represented by hummocky type, where *Sphagnum balticum, S. fuscum, S. capillifolium, Tomentypnum spp., Dicranum spp.,* and *Aulacomnium spp.* occur.

More flooded mires at lower elevations are composed of *Scorpidium spp., Hamatocaulis spp., Aulacomnium spp., Cinclidium spp., Meesia triquetra, Calliergon giganteum,* and *Warnstorfia spp.* Such communities occur in flood valley of the Ulakhan-Sakkyryr River, along a low shore of a small lake near Sakkyryr Settlement, *etc*.

Mires in the upper course of Tumara River, at 1200 m, are different. The dominant species are *Carex stans* (=*C. aquatilis* ssp. *stans*) and *Eriophorum polystachyon*, while other species are much rarer, so only *Saxifraga hirculus* can be mentioned, as a quite characteristic one for this type of habitat. In the beginning of August, mires are flooded by melted permafrost, and many places have no mosses at all. Where mosses are present, the most abundant, floating in water, is *Scorpidium scorpioides*, being often the only moss along tens and hundreds of meters; the next in abundance are *Meesia triquetra* and *Scorpidium revolvens*. All other species are markedly rarer in these flooded places. They appear mainly near permafrost raising; *Sphagnum aongstroemii, S. tundrae, S. capillifolium, S. perfoliatum, S. orientale, Scorpidium cossonii, Tomentypnum spp., Dicranum spp., Orthothecium chryseum, Aulacomnium spp., Philonotis tomentella,* and *Campylium stellatum* occur there. Only in one place *Meesia hexasticha* has been found, forming a big tuft, but covering only about one square decimeter. Interestingly, not a single *Drepanocladus* species was found in these extensive mires, and among *Warnstorfia* the only species is *W. sarmentosa*.

Tundra outside these mires is mostly of lichen and *Dryas* types, with scattered *Dicranum elongatum, Conostomum tetragonum, Bryum amblyodon, Distichum capillaceum, Pohlia nutans, Aulacomnium turgidum, etc*. In more humid places with shrubs of *Betula nana*, the most common is *Sphagnum fuscum*.

Rock fields at higher elevations (above 1000 m) and rocky tundra have quite scattered mosses, which is natural, assuming a low precipitation in the region. The most common on rocks are *Hymenoloma crispulum* and *Andreaea rupestris*. Solitary records in sheltered rock outcrops in tundra are interesting. For example, *Neckera pennata* and *Lescuraea radicosa* were found only once in one of the highest studied localities (but in a rather narrow and ‘well heated’ valley (locality 11).

Specific moss composition is represented on tundro-steppe slopes: very common are *Tortula acaulon* var.

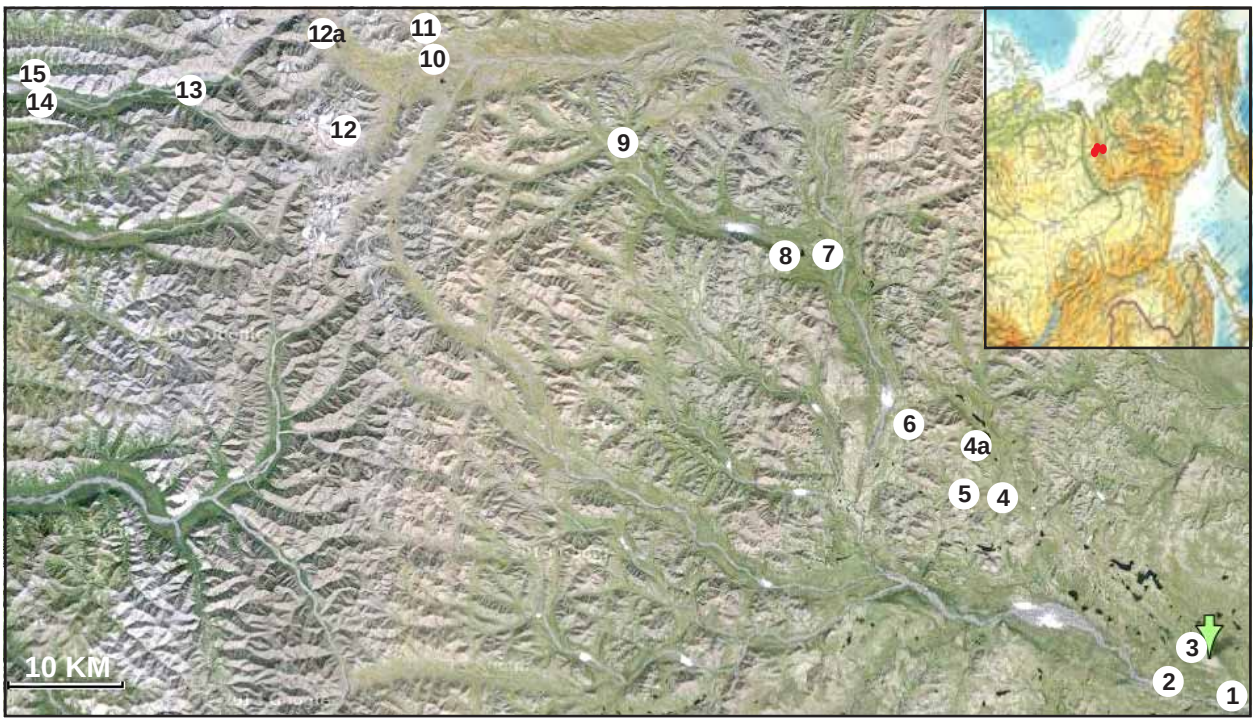


Fig. 1. Study area and collecting localities in Orulgan Range (map of localities is from https://maps.google.ru). Numbers correspond to those in Table 1. Sakkyryr Settlenet is arrowed.

pilifera, Encalypta spp., Didymodon spp. (mainly group of *D. validus*)*, Syntrichia ruralis, Tortella fragilis, Bryoerythrophyllum spp., Distichium capillaceum, Ceratodon purpureus, Bryum argenteum, Pterygoneurum subsessile, P. ovatum, Stegonia latifolia, S. pilifera, Schistidium pulchrum,* and *S. tenerum*. Only on one outcrop we found *Indusiella thianschanica*, although its intentional search was always in mind. Interestingly, *Jaffueliobryum latifolium* which is often associated with *Indusiella* has not been found in the area.

Rocks on the east-facing macroslope, *i.e.*, to the Yana River, are composed of Permian-Triassic aleurolites. Wet cliffy faces indicate rather complex rock composition due to a mixture of calciphilous species (*Cyrtomnium hymenophylloides, Brachythecium cirrosum, Orthothecium strictum, Encalypta procera, Timmia spp., Myurella*) with acidophilous ones *(Amphidium lapponicum, Bartramia ithyphylla, Schistidium boreale*). Other species on these outcrops include: *Pohlia longicollis, Polytrichastrum alpinum, Dicranodontium denudatum, Ditrichum flexicaule, Distichium capillaceum, Isopterygiopsis spp., Mnium thomsonii,* and *Plagiopus oederianus*.

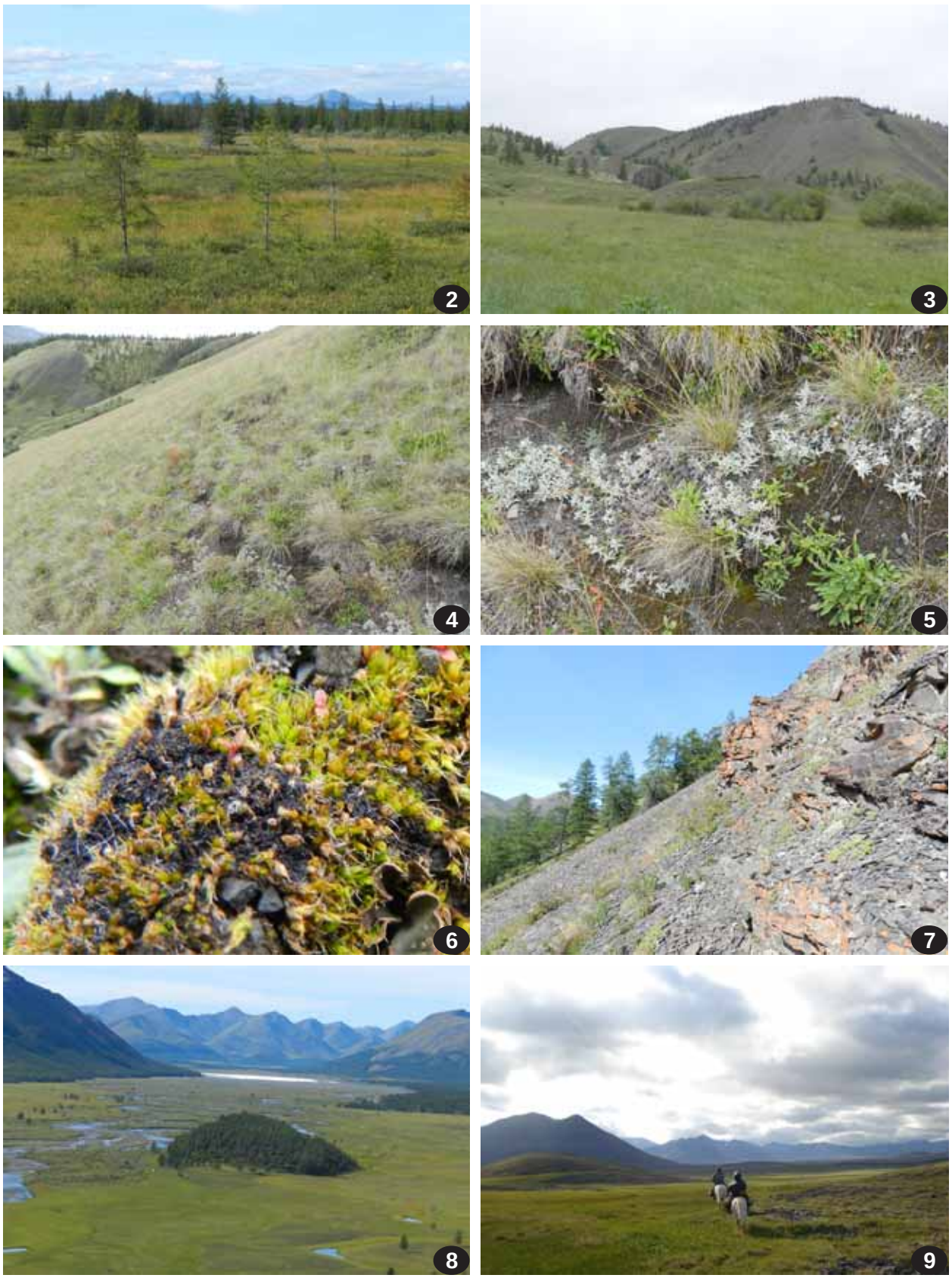
The Lena River macroslope is somewhat different (and likely more calcareous): *Gymnostomum aeruginosum* and *Hymenostylium recurvirostrum* were found only there, both being rather abundant.

Schist outcrops on S-facing slope (locality 15, Fig. 1) are very unstable, as rocks are easily transforming to batches of thin plates, easily crumpling off. Mosses are very few there and two of them, *Anomobryum concinnatum* and *Tortula mucronifolia*, are invariably present on every spot of permafrost melting seepage. Two rare species, *Entosthodon pulchellus* and *Plagiobryum zierii* were found only in this association.

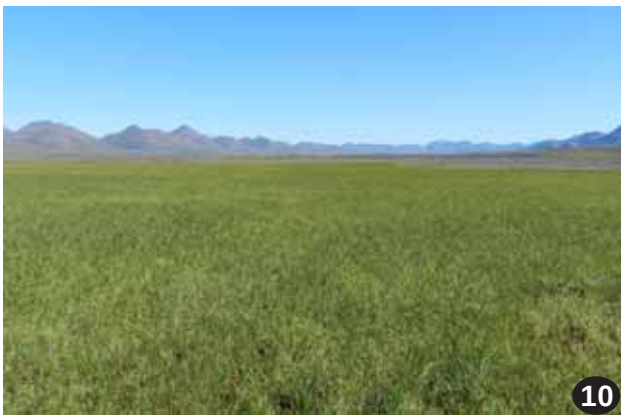
The territory is used by local people mainly as reindeer pastures, thus the dung of these animals is plenty, expecially along trails across forest. *Splachnum luteum* is the most common representative of the genus. Not rare are also *S. sphaericum* and *Tetraplodon mnioides*. Two other *Tetraplodon* species, *T. paradoxus* and *T. pallidus*, were found only in rather dry tundra, while single collection of *Splachnum vasculosum* was made in wet mire along a low lake shore. The *Tetraplodon spp*. tufts in tundra not rarely have admixture of *Ceratodon purpureus*, thus the latter is obviously a coprophilous moss in this area, albeit facultatively. At the same time, we failed to find *Aplodon wormskioldii*, a characteristic Splachnaceae of the Arctic, as well as *Voitia hyperborea*, which however is a rare one.

Disturbed soil banks are rich in mosses, as it commonly takes place in many other northern regions; *Dicranella crispa, D. subulata, D. varia, Ditrichum cylindricum, D. heteromallum, Pohlia beringiensis, Bryum argeneum, Bryum spp., Bryobrittonia longipes, Funaria hygrometrica, Bryoerythrophyllum recurvirostrum* and *Leptobryum pyriforme* are most common in these habitats.

Epiphytic mosses are almost absent in the area, as *Larix* bark in not a good substrate for them, and again, the trunks are only slightly covered by snow in winter. *Chosenia* trunks in localities 14-15, however, gave at once four *Orthotrichum* species in one restricted area, including *O. holmenii*, the species only recently revealed in northern Eurasia (Fedosov et al., 2008).



Figs. 2-9. Study areas in Orulgan Range, for locality numbers see Fig.1. // 2 (loc.1, 450 m alt.): fen in Sakkyryr River valley, with the range behind; 3-6 (loc. 4, 700 m alt.) tundro-steppe on S-facing slope, with *Pterygoneurum ovatum, P. subsessile, Tortula acaulon* var. *pilifera*; 7 (loc. 7): argillite outcrop with *Grimmia anodon* and *Indisiella thianschanica*; 8 (loc. 7, 850 m alt.): view to south from #7, showing Tumara River Valley and permanent valley ice-field (near loc. 6 in Fig.1); 9 (loc. between 5 and 6, 950 m alt.), an average watershed landscape, mixture of tundra and *Sphagnum* hummocks.



Figs. 10-17. Study areas in Orulgan Range, for locality numbers see Fig.1. // 10&12 (loc.10, 1200 m alt.): Tumara River upper course, *Carex stans+Scorpidium scorpioides* community; 11 (loc.10, 1200 m alt.), reindeer camp in *Kobresia* tundra near fen in previous picture; 13 (loc. 10, 1200 m alt.) *Sphagnum rubellum, S. aongstroemii, S. lenense* on small permafrost raising in Scorpidium fen; 14 (loc.11, 1300 m alt.) rocky *Dryas* tundra on slope to fen and marmot; 15-17 (loc. 12, 1500-1900 m alt.) glacier Kovsh area, with few mosses, *Hymenoloma crispa* and *Andreaea rupestris* being the most common (Fig. 17).

Figs. 18-25. West macroslope of Orulgan Range, locs. 13-15 in Fig.1. // 18: Aenigan-Tolonoo Creek valley, 800 m; 19-21: schist outcrops, 650 m alt., with *Distichium inclinatum* (Fig. 19) and *Anomobryum concinnatum* (Fig. 21) on seepage of melting permafrost; 22: 800 m, *Pinus pumila* on S-faced slope, with *Aloina rigida* and *Pterygoneurum ovatum*; 23: *Alnus fruticosa* thicket, 650 m alt., a shelter for*Cyrtomnium hymenophylloides, Brachythecium spp., Mnium spp., Myurella spp., Cynodontium spp.*; 24-25: *Larix* forest in flood valley, 600 m, often recovering after catastrophic floodings, where *Rhytidium rugosum* is often the only species (Fig. 24).

SPECIES LIST

The nomenclature follows Ignatov, Afonina, Ignatova et al. (2006). After the species name collecting point(s) – altitudinal range – habitats are given.

Abietinella abietina – 1, 9, 11, 12, 13, 14 – 470-1500 m – tundro-steppe slopes, rock outcrops, willow shrubs along streams, gravely bars, tundra, rock-fields in *Larix* forests.

Aloina rigida – 4, 7, 13, 14 – 650-850 m – on soil on eroded slope near cliffs and in tundro-steppe communities, S+.

Amblystegium serpens – 13 – 600 m – *Chosenia* forest in valley on Lena River side of range, on rotten logs, tree bases, soil banks of small temporary brook.

Amphidium lapponicum – 4 – 670 m – red aleurolite outcrops at base of slope to D'aybalaakh Creek.

A. mougeotii – 8, 10 – 1000-1300 m – north-faced rock outcrops in forestless belt.

Andreaea rupestris – 6, 10, 11, 12 – 800-1500 m – rocks and cliffs, near snow-fields on fine earth.

Anomobryum concinnatum – 13-15 – 650-900 m – schists talus and cliffs along Aenigan-Toloono Creek (Lena River Basin), very common and in many places one of few species (often with *Tortula mucronifolia*).

Aulacomnium acuminatum – 4 – 700 m – ravine bottom, between tundro-steppe slopes.

A. palustre – 1, 2, 3, 4, 7, 11 – 450-1200 – various mires, wet boggy *Betula* and *Salix* shrubs, brook and lake sides, *Poa* meadows, wet *Larix* forests, *etc*., very common.

A. turgidum – 1, 5, 11, 12, 13 – 450-1500 m – mesic *Larix* forests and open *Larix* stands, bogs, tundra, rock outcrops.

Bartramia ithyphylla – 6, 11, 12, 13, – 800-1350 m – rocks and soil near rock outcrops, in tundra, occasionally in open places, but more commonly in sheltered ones (near rocks, *etc.*).

B. pomiformis – 4, 6, 12 – 670-1350 m – red aleurolite outcrops at slope bottom and rocks along stream in tundra.

Brachytheciastrum trachypodium – 2, 4, 6, 7, 8 – 470-1000 m – various rock outctops, on more or less sheltered faces (*e.g*. under tree canopy), on soil in dry *Larix* forest on slopes.

Brachythecium boreale – 6, 13, 14 – 650-800 m – wet rocks, gravely bars, in *Alnus fruticosa* thickets and in *Salix* shrubs.

B. cirrosum – 4, 8, 13 – 670-1000 m – wet rock outcrops in valleys or on N-facing slopes; rare.

B. erythrorrhizon – 12, 13, 14 – 600-1400 m – *Chosenia* stands in Aenigan-Tolonoo River flood valley, on rotten logs and soil in forest, occasionally among rocks above tree line.

B. jacuticum – 10, 12, 13 – 800-1350 m – tundra, gravely bars, rocks beside brooks, *etc.*, sporadic near and above tree line.

B. mildeanum – 7, 8 – 800-850 m – brook bank and wet *Poa* meadow.

B. turgidum – 10, 12, 13, 14 – 650 1395 m – not rare above tree line in moderately wet places.

B. udum – 10 – 1200 m – wet place at base of rocky talus.

Bryobryttonia longipes – 3 – 500 m – eroded soil near stream and banks along it.

Bryoerythrophyllum ferruginascens – 15 – 600 m – landslide on steep slope.

B. latinervium – 4 – 670 m – red aleurolite outcrops.

B. recurvirostrum – 4, 13, 14 – 600-900 m – base of *Chosenia*, red aleurolite, grey rocks and schist outcrops.

Bryum algovicum –1 – 450 m – on soil on disturbed place in river valley.

B. amblyodon – 4, 8, 11, 12, 13 – 670-1350 m – rock fields and outcrops, on soil along streams, in tundra and tundro-steppe, on old road in wet meadow, in *Alnus* thickets.

B. archangelicum – 7, 9 – 850-1100 m – only along Dzhelon Creek valley: in tundra and tundro-steppe, on old road in wet meadow.

B. argenteum – 1, 2, 4, 7, 9, 11 – 450-1300 m – in disturbed places, on soil and rocks on tundro-steppe slopes, on brook banks in tundra.

B. bimum – 6, 5 – 800-1000 m – on N-facng cliffs and among mosses on wet slope.

B. creberrimum – 4, 8, 13, 14, 15 – 650-1000 m – rocks (mostly rather wet), landslides.

B. cyclophyllum – 1, 3, 9 – 450-1100 m – in mires and wet tundra.

B. lonchocaulon – 10 – 1200 m – temporary brook bed.

B. neodamense – 6 – 800 m – small bog in stream valley.

B. pseudotriquetrum – 1, 3, 4, 6, 10, 13, 14, 15 – 450-1200 m – various mires, hummocks, wet rock outcrops.

Calliergon giganteum – 3, 8, 14 – 500-850 m – grassy wetlands, brook sides; locally common, but never found above tree line.

Calliergonella cuspidata – 9 – 1100 m – upper course of Dzhelon Creek, rut of 'winter road' in meadow.

C. lindbergii – 2, 4, 10 – 470-1200 m – swampy *Larix* forest, brook sides, grassy and shrubby wetlands, rut of 'winter road', strongly trumpled reindeer pastures.

Campylium protensum – 9 –1100 m – upper course of Dzhelon Creek, rut of old road.

C. stellatum – 1, 4, 7, 8, 10, 11, 12 – 450-1500 m – fens, mires, meadows, wet faces of rock outcrops, brook banks, old road pits, wet rocky tundra (base of talus).

Catoscopium nigritum – 10 – 1350 m – *Dryas* tundra on S-facing slope, on rocks.

Ceratodon purpureus – 1, 2, 6, 8, 10, 11, 14 – 450-1300 m – dry *Larix* forest, rock fields, cliff niches, tundro-steppe slopes, various disturbed places in forest and in open places in flat tundra and on slopes.

Cinclidium arcticum – 3, 6, 7, 9, 10, 14 – 500-1200 m – various minerotrophic mires, lake sides, flat extensive *Carex*+ *Eriophorum* mires above tree line, grassy (*Poa*) wetlands, wet rockoutcrops, wet mossy *Larix* forests.

C. latifolium – 3 – 500 m – mire along lake shore.

C. stygium – 15 – 650 m – wet place in flood valley.

C. subrotundum – 3; 5, 10 – 500-1200 m – mire around lake, willow shrubs in a small creek valley, eutropic wet tundra.

Climacium dendroides – 1, 3 – 470-500 – near Sakkyryr Settlement, wet *Larix* forest and *Betula nana* shrubs along brook.

Cnestrum alpestre – 5, 9 – 780-1100 m – along stream banks and in rock fields, rare.

C. glaucescens – 12 – 1350 m – on soil among rocks at base of talus of slope not far from glacier.

C. schistii – 8, 10, 13 – 650-1200 m – cliffs on N-facing slopes and rocks in tundra.

Conostomum tetragonum – 10 – 1200 m – in a relatively dry tundra, including trumpled reindeer pastures.

Cratoneuron curvicaule – 3, 15 – 500-774 m – mires around lakes, wet schist cliff faces.

Cynodontium asperifolium – 14 – 600 – base of *Larix* trunk in flood valley forest.

C. strumiferum – 7, 8, 12, 13 – 800-1350 m – on soil on slopes in forests, shady places on open slopes, at cliff bases, in *Dryas* tundra close to glacier, *etc*.

C. tenellum – 5, 6, 13 – 780-850 m – on soil at tree bases, among rocks on rock fields.

Cyrtomnium hymenophylloides – 6, 8, 12, 13, 15 – 650-1500 m – on rocks.

Dichodontium pellucidum – 15 – 650-1350 m – rocks along stream, occasionally at *Alnus* trunk bases.

Dicranella crispa – 1, 2, 9 – 450-1100 m – soil bank along stream, tree roots in forest, along trails and old roads and in variously disturbed sites in settlement, on eroded hummock sides.

D. subulata – 1, 7, 12 – 450-1500 m – soil bank along stream, tree roots in forest, along trails and old roads and in variously disturbed sites in and near settlement; also on eroded hummock sides.

D. varia – 1, 3 – 450-500 m – bare soil along stream bank and on eroded sides of permafrost hills near Sakkyryr Settlement.

Dicranum acutifolium – 8, 12, 15 – 800-1500 m – mires, wet and rather dry tundra communities, rock niches, willow shrubs.

D. bardunovii – 7, 10, 14 – 630-1200 m – wet cliffs and slopes in forest, within moss carpet, in open rocky tundra.

D. elongatum – 1, 2, 6, 7, 8, 10, 11, 12, 13, 14, 15 – 450-1350 m – hummocks in mires of various types, on soil in tundra and in open *Larix* stands, both dry and boggy; on rock outcrops and rock fields, occasionally at base of *Chosenia* trunks, on disturbed sites in meadows, in depressions in tundro-steppes; common, occurs in a wide range of habitats.

D. laevidens – 1, 2, 5, 6, 8, 13, 15 – 450-1300 m – open *Larix* forests, both dry lichen type and *Sphagnum* boggy ones, hummocks, rock fields within forested areas, sedge mires and moss-lichen tundras on plateaus, at cliff bases.

Dicranodontium denudatum – 14 – 650 m – on big rocks on slope in forest.

Didymodon fallax –13 – 850 m – wet cliff base.

D. ferrugineus – 8 – 1100 m – rock outcrops on open N-bacing slope, above tree line

D. icmadophilus – 15 – 600 m – rocks at base of steep slope.

D. johansenii – 5, 8, 13 – 800 m – both N-and S-facing cliffs, in crevices sheltered from rain by overhangs.

D. rigidulus – 11 – 1300 m – dry cliff crevice in mountain tundra belt.

D. validus – 2, 4, 5, 7 – 470-850 m – dry rock outcrops and low rocks on tundro-steppe slopes; not rare but in a rather restricted part of the study area.

Distichium capillaceum – 2, 3, 4, 9, 13, 14, 15 – 470-1300 m – tundro-steppes, various soil banks on slopes, both in forest and in mountain tundra belt, wet soil banks along streams, cliff crevices, on soil under *Pinus pumila*, pits on old road on meadow, rather common.

D. inclinatum – 6, 14 – 650 m – wet and moderately shady cliffs along small creeks and on N-facing slopes, rare.

Ditrichum cylindricum – 1, 2, 4, 10 – 450-1200 m – eroded sides of permafrost raisings, pits on old roads in forests and meadows, occasionally in tundra strongly damaged by reindeers.

D. flexicaule – 2, 4, 6, 8, 14 – 470-1200 m – sporadically on wet cliffs, and occasionally in tundra, at stream banks, on upturned roots of fallen and inclined trunks.

D. heteromallum – 1 – 450 – one collection on old road in *Larix* stand, not far from settlement.

Drepanium recurvatum – 12, 13, 14 –650-1500 – wet exposed cliffs in narrow valley of small creek and in moss-lichen rocky tundra.

Drepanocladus aduncus – 1, 4, 13,14, 15 – 450-787 m – mires, stream banks, on soil in *Chosenia* forest and *Salix* shrubs in flood valleys, in wet meadows.

Encalypta affinis – 4, 8 – 670-1000 m – two findings: on red aleurolite outcrops in valley and on grey metamorphic rocks on open N-facing slope above tree line.

E. alpina – 10, 13 – 850 m – wet cliffs.

E. brevicolla – 10 – 1200 m – one finding in tundra.

E. brevipes – 8, 12 – 1000-1350 m – cliffs above tree line.

E. ciliata – 8 – 1000 m – cliffs on N-facing slope; one more sterile collection on old road near settlement (3 – 470 m) likely also belongs to this species.

E. mutica – 13, 14 – 670-900 m – cliffs in rather deep canyons.

E. pilifera – 4, 5, 7, 15 – 700-850 m – tundro-steppes on steep S-facing slopes.

E. procera – 5, 8, 13, 14, 15 – 650-1500 m – not rare on wet cliffs and rock outcrops.

E. rhaptocarpa – 2, 5, 7, 8, 9, 12, 13 – 470-1750 m – common in various habitats on rocks and soil, mostly on rock outcrops, but also on various soil banks; occasionally found on old forest roads, common on open xeric slopes with tundro-steppe.

Entosthodon pulchellus – 15 – 700 m – dripping schist cliffs on S-facing slope.

Eurhynchiastrum pulchellum – 1, 2, 4, 5, 10, 13, 15 – 450-1100 m – slopes in forests and tundro-steppes, rock outcrops, sides of hummocks.

Fissidens adianthoides – 2, 4, 10 – 470-1200 m – old roads on wet meadows, bottom of ravine, brook banks in tundra, rather rare.

F. bryoides – 11, 13 – 650-1300 m – rock outcrop and brook bank, only two localities.

F. osmundoides – 5 – 780 m – stream in forest, wet bank with Sphagna.

Fontinalis antypyretica – 4 – 670 m – in running water of Dyaballakh Creek.

Funaria hygrometrica – 1, 2, 12, 15 – 450 m – eroded slopes, trails, schist talus, nival habitats near glacier.

Grimmia anodon – 5, 7, 11, 10, 13 – 850-1300 m – S-facing rock outcrops.

G. elatior – 11 – 1300 m – dry cliffs in narrow valley in mountain tundra belt, in only one locality.

G. jacutica – 6 – 800 m – rock field on slope in open *Larix* forest.

G. longirostris – 2, 5, 7, 13, 15 – 470-1750 m – various rock outcrops and cliffs, including low rocks on tundro-steppe slopes; more commonly in moderately dry habitats.

G. reflexidens – 11, 12 – 1300-1400 m – rocks in mountain tundra belt.

Gymnostomum aeruginosum – 13, 14, 15 – 670-850 m – rock outcrops with seepage of melting permafrost; common in schist and sandstone area along Aenigan-Tolonoo Creek, but never found in other visited sites.

Hamatocaulis lapponicus – 3 – 500 m – fen around small lake.

H. vernicosus – 1, 7, 10 – 450-1200 m – sedge mires, lake sides, tundra.

Hygrohypnella polaris – 6, 11, 12 – 900-1370 m – in streams and creeks and other permanently wet places, *e.g.*, base of rock field where the water from melting permafrost is coming out, rocky place within flat mires, wet cliffs, rocks near waterfall, occasionally in tundra.

Hygrohypnum luridum – 6, 14, – 650-900 m – rocks along and in streams.

Hylocomium splendens var. *obtusifolium* – 1-3, 11, 12, 14 – 450-1500 m – forests, mires, tundra, rock outcrops, very common.

Hymenoloma crispulum – 10, 11, 12 – 1300-1500 m – on rocks

in mountain tundra belt, often near glaciers, occasionally in rocky tundra.

Hymenostylium recurvirostrum – 13, 14, 15 – 650-850 m – wet rock outcrops (schists and sandstone).

Hypnum cupressiforme – 2, 7, 11, 13 – 470-1300 m – cliffs and rock outcrops.

Indusiella thianschanica – 7 – 850 m – xeric rock outcrop on S-facing slope.

Isopterygiopsis pulchella – 2, 6, 7, 12, 13, 14 – 470-1500 m – on soil near rock oucrops, in forests, tundra, on tundro-steppe slopes.

Kiaeria blyttii – 12 – 1500 m – rock field near glacier.

Leptobryum pyriforme – 1, 3 – 450-500 m – old roads, eroded slopes in forests and shrubs.

Lescuraea radicosa – 11 – 1300 m – cliff near small glacier.

Loeskypnum badium – 10, 15 – 600-1200 m – minerotrophic bogs in forest and mountain tundra belt, base of talus with water from melting permafrost.

Lyellia aspera – 6, 10 – 850-1000 m – on slopes within thick mossy forest.

Meesia hexasticha – 10 – 1200 m – one collection in sedge eutrophic mire on flat plateau area.

M. triquetra – 3, 10 – 500-1200 m – minerotrophic mires.

M. uliginosa – 6, 10, 11, 12, 15 – 600-1300 m – various mires, especially hummocks; also brook banks, wet cliffs, and tundra.

Mnium blyttii – 13, 15 – 600-900 m – on rocks, among other mosses, on sides of hummocks in bog, rather rare.

M. lycopodioides – 6, 10, 14, 15 – 600-1200 m – brook banks, shaded cliff niches, and at cliff bases.

M. marginatum – 13 – 800 m – on soil in *Salix* shrubs in flood valley.

M. thomsonii – 5, 13 – 670-850 m – various rock outcrops.

Myurella julacea – 1, 3, 4, 8, 11-15 – 450-1400 m – rock outcrops, soil banks on slopes in mesic conditions, hummocks in bogs, tundro-steppe.

M. tenerrima – 8, 11, 14 – 670-1350 m – mesic and wet rock outcrops.

Neckera pennata – 11, 13 – 900-1300 m – two findings in forest and mountain tundra belts on rock outcrops.

Niphotrichum canescens – 14 – 850 m – talus on valley slope.

N. panschii – 12 – 1350-1500 m – rock outcrops along a creek near glacier.

Oligotrichum falcatum – 12 – 1500 m – on soil among rocks on N-facing talus slope near glacier.

Oncophorus wahlenbergii – 5 – 670 – rock outcrops, soil under upturned roots, meadows, bogs with hummocks, rich fens, moss-lichen tundra, rock fields.

Orthothecium chryseon – 5, 6, 11, 12, 13, 14 – 780-1500 m – wet places in tundra, wet cliffs in forest belt, among Sphagna in stream valleys, within *Salix* shrubs, in small springy mires.

O. strictum – 5, 6, 10, 11, 13, 14, 15 – 600-1500 m – on wet cliffs and rock outcrops, and in mountain tundra belt also on rocks along stream near glacier and in moss-lichen tundra on gentle slope.

Orthotrichum holmenii – 15 – 600 m – one collection on *Chosenia* in flood valley of Aenigan-Tolonoo Creek.

O. iwatsukii – 2, 5, 6, 7, 8, 14, 15– 470-1200 m – on rocks in mesic habitats (*e.g.*, rock fields in forests), N-facing cliffs.

O. obtusifolium – 7, 15 – 600-850 m – once found on rocks on xeric S-facing slope and once on *Chosenia* in flood valley of Aenigan-Tolonoo Creek.

O. pallens – 6 – 800 m – rock field in forest.

O. rupestre – 8 – 1000 m – rock outcrops on steep N-facing slope above tree-line.

O. sordidum – 15 – 600 m – one collection on *Chosenia* in flood valley of Aenigan-Tolonoo Creek.

O. speciosum – 14 – 650 m – on *Alnus (Dusheckia) fruticosa* trunk in valley of small stream.

Philonotis tomentella – 2-7, 10, 13, 14, – 470-1300 m – swampy meadows, brook and lake sides, various mires, within *Sphagnum* covered areas in valleys, bases of cliffs and rocks seeping by melting permafrost, wet mossy and rocky tundra and occasionally various other habitats.

Plagiobryum zierii – 15 – 700 – schist outcrops on S-facing slope, in a habitat regularly wetted by permaforst melting.

Plagiomnium curvatulum – 5, 6, 8, 10, 11, 14 – 650-1300 m – bases of wet cliffs, brook banks, wet tundra.

P. ellipticum – 1, 2, 3 – 450-500 – swampy areas near lakes and in open *Larix* forests, brook sides.

P. medium – 13, 14 – 650-800 m – on rocks and on soil in *Alnus* stand at base of steep slope.

Plagiopus oederianus – 4, 8, 14 – 650-1000 m – shaded to moderately exposed mesic rock outcrops.

Plagiothecium berggrenianum – 5, 14, – 630-780 m – side faces of wet and shady boulders, once on rotten log beside stream.

P. cavifolium – 11, 14 – 650-1300 m – wet rocks along stream and in tundra.

P. laetum – 6, 13, 14 – 630-900 m – rocks on rock-fields in forests.

Platydictia jungermannioides – 13 – 900 m – mossy rock field on slope in open forest.

Platygyrium repens – 13 – 850 – at base of *Pinus pumila* and *Alnus (Duschekia) fruticosa* trunks at bottom of sunny S-facing slope in narrow rather warm valley in the upper course of Aenigan-Tolonoo Creek.

Pleurozium schreberi –14 – 650 m – rather common in forest belt in mexic and moderately wet habitats.

Pogonatum urnigerum – 5, 11 – 780-1300 m – soil banks along streams, cliff niches.

Pohlia andrewsii – 3, 10 – 500-1200 m – soil bank near stream in forest and disturbed place in tundra on reindeer pasture.

P. beringiensis – 12 – 1350 m – *Dryas* tundra on slope in valley, not far from glacier.

P. cruda – 2, 5, 8, 14, 15 – 470-1350 m – various soil banks on steep slopes, along brooks, at cliff bases, in crevices on rock outcrops, occasionally in moss-lichen and *Dryas* tundra.

P. drummondii – 10 – 1200 m – disturbed soil near stream in reindeer pasture.

P. elongata – 15 – 800 m – wet soil near rock outcrop and in mossy *Larix* forests.

P. longicollis – 5, 7, 14, 15 – 650-820 m – rock outcrops, on soil under upturned roots of fallen trunk, in willow shrubs on hummock side, on bare soil at edge of forest and tundro-steppe slope; rather rare but in a variety of habitats.

P. nutans – 1, 2, 3, 7, 10, 15 – 450-1200 m – on soil in dry *Larix* forests dominated by lichens, among mosses in forests and bogs, on various slopes, permafrost raisings in tundra, rotten logs and stumps.

P. proligera – 1 – 450 – eroded side of permafrost raising.

P. wahlenbergii – 14 – 700 m – wet schist cliffs.

Polytrichastrum alpinum – 1, 3, 5, 6, 11, 13, 14 – 450-1500 m – rock outcrops, rock fields, stream banks, on bare soil or within moss carpet or among grasses, occasionally among mosses in forest floor, in moss-lichen tundra.

Polytrichum hyperboreum – 8, 10, 13 – 800-1200 m – *Poa* meadow, willow shrubs, tundra.

P. jensenii – 3, 10 – 500-1200 m – wet mires at lake sides in forest belt and sedge mires (trampled by reindeers) in mountain tundra belt.

P. juniperinum – 10, 13 – 800-1200 m – wet *Larix* forest, wet tundra trampled by reindeers.

P. strictum – 1, 2, 6, 7, 13 – 450-1200 m – old roads, occasionally trunk bases, open slopes with *Hylocomium*, *Poa* meadows, *Sphagnum* bogs within both forest and mountain tundra belt.

Pseudoleskeella catenulata – 4 – 670 m – outcrops of red aleurolites.

P. rupestris – 4, 11 – 670-1300 m – rock outcrops, two collections.

P. tectorum – 4, 5, 8, 13, 15– 670-1000 m – rock outcrops (mostly S-faced), especially on schists.

Psilopilum cavifolium – 10 – 1200 m – tundra near stream, strongly trampled by reindeers.

P. laevigatum – 1 – 450 m – old roads in forests.

Pterygoneurum ovatum – 4, 7, 13 – 680-850 m – tundro-steppe and rock outcrops on S-facing slopes.

P. subsessile – 4, 7 – 680-850 m – tundro-steppe and rock outcrops on S-facing slopes.

Ptilium crista-castrensis – 13, 14 – 650-800 m – among mosses on rock outcrops and in *Larix* forest; only on the Lena River macroslope.

Pylaisia polyantha – 14 – 600-650 m – rare, on *Chosenia* in *Chosenia* stands in flood valley, on rotten twigs in *Alnus* thickets.

Racomitrium lanuginosum – 6, 8, 10, 12, 13, 15 – 800-1400 m – rock fields and outcrops, mossy and lichen tundra, nival communities.

Rhizomnium andrewsianum – 15 – 600 m – hummocky bog with *Betula nana*.

Rhytidium rugosum – 2, 7, 10 – 470-1200 m – tundro-steppes, lichen tundra, rock outcrops, dry *Larix* forest.

Saelania glaucescens – 4, 6, 8, 13 – 780-1000 m – soil banks, rock outcrops and cliff crevices.

Sanionia uncinata – 1, 4, 5, 10, 11, 12, 13, 14, – 450-1500 m – in mires, forest floor, willow shrubs, rock fields and outcrops, tundra.

Schistidium boreale – 15 – 750 m – wet shaded rock outcrops.

S. frigidum – 11, 12, 13 – 800-1400 m – rock outcrops and lithosoil near their bases.

S. papillosum – 12 –1450-1500 m – only in one locality near glacier, on rocks of talus slope.

S. platyphyllum – 4, 6, 10, 11, 12, 13, 14 – 650-1500 m – wet rocks along streams and creeks, edges of glacier and snow fields, occasionally on soil on stream bars.

S. pulchrum – 2, 4, 5, 8, 12, 13, 14, 15 – 470-1400 m – rock outcrops (both light-grey, grey and red solid rocks and dark grey schists) and low rocks on tundro-steppe slopes.

S. tenerum – 5, 7, 8 – 850-1000 m – xeric S-facing rock outcrops, on lithosoil in tundro-steppes, more rarely on shady cliffs.

Scorpidium cossonii – 4, 6, 10 – 900-1200 m – mire in valley of small creek, wet rock outcrops, wet stream bank in tundra; rare.

S. revolvens – 1, 6, 8, 9, 10, 14, 15 – 450-1200 m – minerotrophic mires, hummocks, shrubby communities, *Poa* meadows, at the border between tundra and mire on plateau, in streams in mountain tundra belt.

S. scorpioides – 3, 8, 10 – 500-1200 m – mires around lakes in forest belt, in tundra belt very common in flat *Carex stans* and *Eriophorum polystachyon* dominated mires, being the most abundant and sometimes almost single moss at great areas.

Sphagnum angustifolium – 5 – 780 m – brook bank in *Larix* forest.

S. aongstroemii – 6, 10 – 850-1200 m – found once on *Sphagnum* slope in *Larix* forest and rather common in flat sedge and cotton-grass mires on plateau, marking earliest stages of permafrost raisings; also in wet tundra communities.

S. balticum – 6, 10 – 800-1200 m – *Sphagnum* hummock with *Betula nana*, and occasionally in flat sedge and cotton-grass mires on plateau, marking earliest stages of permafrost raisings.

S. capillifolium – 2, 5, 9, 10, 15 – 470-1200 m – small *Sphagnum* patches in tundra, rather wet *Larix* forests, wet (flooded by permafrost melting) cotton-grass tundra, *Sphagnum* hummocks with *Betula nana*.

S. compactum – 10 – 1200 m – along edge of *Sphagnum* bog in tundra.

S. fimbriatum – 3 – 500 m – side of brook in *Larix* forest.

S. fuscum – 2, 3, 8, 15 – 470-850 m – stream banks, boggy *Larix* forests, hummocks appearing on flat mire surface and of mineral permafrost raisings, hummocks with *Betula nana*, wet *Poa* meadows.

S. inexpectatum – 10 – 1200 m – in flat sedge and cotton-grass mires on plateau, marking earliest stages of permafrost raisings and also along transitions to dryer tundra communities.

S. lenense – 10 – 1200 m – one collection in wet cotton-grass tundra on plateau.

S. mirum – 10 – 1200 m – one collection in sedge mire on plateau.

S. orientale – 3, 8, 10 – 500-1200 m – hollow in flood valley, in flat sedge and cotton-grass mires on plateau, mire around lake, usually in quite wet habitats.

S. perfoliatum – 10 – 1200 m – wet (flooded by permafrost melting) mire on plateau, with sedge and dominated by *Scorpidium scorpioides*.

S. rubellum – 9, 10 – 800-1200 m – tundra/mire border, *Sphagnum +Betula nana* hummock, *Sphagnum* communities on steep slopes.

S. squarrosum – 3 – 500 m – boggy lake shore and permafrost raising near the same lake.

S. teres – 10 – 1200 m – mire along lower edge of talus.

S. tundrae – 9, 10 – 1100-1200 m – mires and wet tundra above tree line.

S. warnstorfii – 10 – 1200 m – edge of *Sphagnum* mire on plateau.

Splachnum luteum – 2, 13, 14 – 470-700 m – near reindeer farms and along trails in mossy forests.

S. sphaericum – 1, 2, 10, 13 – 450-1200 m – dry open *Larix* forest, especially near reindeer farm, mossy *Larix* forest, wet eutrophic tundra and sedge bogs.

S. vasulosum – 3 – 500 m – in wet mire at lake shore.

Stegonia latifolia – 7, 9 – 850-1100 m – S-facing xeric slopes.

S. pilifera – 7 – 850 m – S-facing xeric slope.

Stereodon bambergeri – 14 – 650 m – rocks near a stream – tributary of Aenigan-Tolonoo Creek.

S. holmenii – 5, 9 – 780-1100 m – on soil on slopes.

S. revolutus – 8 – 1100 m – N-facing rock outcrops.

S. subimponens – 5 – 780 m – slope to stream in *Larix* forest, at *Larix* base.

S. vaucheri – 4, 7, 8 – 670-1000 m – mesic to xeric rock outcrops.

Straminergon stramieum – 10 – 1200 m – wet boggy place at base of talus slope.

Streblotrichum convolutum – 2, 5, 7 – 470-850 m – disturbed places near settlements, xeric tundro-steppe slopes, among big rocks on slopes.
Syntrichia norvegica – 11 – 1300 m – rocky tundra.
S. ruralis – 2, 4, 6-9, 11-15 – 470-1500 m – tundro-steppe, tundra, rock outcrops, occasionally on rotten logs in forest.
Tetraplodon mnioides – 1, 2, 13, 14, 15 – 450-900 m – animal remains which are usually almost totally decomposed, in dry to mesic, lichen to mossy *Larix* forests, occasionally on rock outcrops; all findings are within the forest belt.
T. pallidus – 10 – 1200 m – on animal remains in tundra (at base of talus slope).
T. paradoxus – 10, 12 – 1200-1350 m – on animal remains in mossy-lichen and *Dryas* tundra.
Thuidium assimile – 3, 4, 9, 13, 14 – 500-1100 m – hummock near lake, near rock outcrops, old road in meadow, mossy *Larix* forest, willow shrubs.
Timmia austriaca – 4, 12, 13, 15 – 670-1350 m – rock outcrops and rock fields.
T. comata – 6, 8, 13, 14, 15 – 650-1000 m – wet cliffs and rock outcrops.
T. sibirica – 12, 13, 14 – 650-1500 m – wet rock outcrops.
Tomentypnum falcifolium – 1, 3, 8, 9, 10 – 450-1400 m – wet parts of mires, more commonly in tundra in wide range of habitats.
T. nitens – 1, 6, 7, 10, 14, 15 – 450-1350 m – boggy hummocks, wet places with Sphagna in valleys and in tundra, *Poa* meadows, wet to rather dry *Dryas* variants of tundra.
Tortella alpicola – 12, 13 – 850-1500 m – on shaded rocks.
T. fragilis – 1, 2, 7-10, 13 – 450-1200 m – wet places in *Sphagnum* and sedge bogs with some permafrost hummocks, on soil in wet *Poa* meadows, on wet stream bank in tundra and also in contrastingly different habitats on xeric S-facing tundro-steppe slopes.
T. tortuosa – 15 – 800 m – schist cliffs on S-facing slope, not rare but only in one locality.
Tortula acaulon var. *pilifera* – 2, 4 – 470-850 m – tundro-steppe on xeric S-facing slopes.
T. cernua – 14 – 670 m – wet schist rock outcrops.
T. cuneifolia – 15 – 670 m – one collection from wet schist cliff.
T. hoppeana – 7 – 800 m – steep slope (near small forest stand in otherwise forestless area).
T. mucronifolia – 6, 4, 11, 13, 14, 15 – 650-1300 m – sporadically on wet cliffs, but very common on schists.
T. systylia – 8, 13 – 800 m – on soil banks in flood valleys.
Trichostomum crispulum – 14, 15 – 670-800 m – rock outcrops, grey solid rocks and schists.
Warnstorfia exannulata – 3, 8 – 500-800 m – boggy lake shores and swampy depressions.
W. fuitans – 8 – 800 m – small deep hollow on creek terrace.
W. pseudostraminea – 1, 8, 14 – 450-800m – hollows in valleys and near streams, always within forest belt.
W. sarmentosa – 8, 9, 10 – 850-1200 m – in streams and on their banks, hollows in mires in tundra belt, as well as in very wet flat sedge mires.

DISCUSSION

The present list includes 241 species. We cannot pretend it to be complete, considering only two week work, and subtracting considerable time for travelling by horses. At the same time, the largest previous list of geobotanical collections done mostly by Prefiljeva and identified by Afonina (Afonina & Perfiljeva, 1981) included 119 species (there were 128 species in their list, but some of them were from another lowland area). Their collections from Orulgan Range were made in the territory ca. 200 km south from our study area, and almost all species in that publication were the same as in the present list.

Another area, ca. 200 km to the east, the Yana-Adycha Plateau has been studied recently by Isakova (2010), who found there 177 moss species. This area has generally lower elevations, 100-700 m, but one peak was investigated up to 1293 m, thus the environmantal conditions are about the same in many respects. The species composition is also rather similar to that in Orulgan, although there were some rare xerophytic species which we failed to find in Orulgan, *e.g.*, *Hilpertia velenowskyi, Syntrichia caninervis, Pterygoneurum kozlovii, Hedwigia ciliata* and *Fabronia ciliaris*. From another side, Orulgan flora has *Entosthodon pulchellus, Indusiella thianschanica*, *Grimmia anodon, Aloina rigida, Tortula acaulon* var. *pilifera, Didymodon icmadophilus, D. johansenii, Bryoerythrophyllum latinervium, Stegonia latifolia, S. pilifera,* which were not revealed in the Yana-Adycha Plateau. Thus, only few xerophytes common for both area are known: *Syntrichia ruralis, Tortella fragilis, Pterygoneurum subsessile, P. ovatum,* and *Schistidium tenerum*.

The nearest from the West to Orulgan and well studied moss flora is that of Anabar Plateau (Fedosov et al., 2011), which is likely most rich in xerophytes Subarctic moss flora. This area is somewhat more northern than Orulgan (200-400 km north), although its zonal position appears to be the same, because this longitudinal sector is known as having the northernmost forest in the world, at 74°N (cf. Afonina, 1978). Situated ca. 1000 km west from Orulgan, the Anabar Plateau has moss flora including additionally such xerophytes as *Jaffueliobryum latifolium, Tortula lanceola, T. obtusifolia, Tortella densa, Pseudocrossidium obtusulum, Microbryum starckeanum, M. davallianum, Weissia brachycarpa,* and *Grimmia tergestina*. These species were also intentionally searched in Orulgan, but were not found. Among Yakutian species listed above, almost all occur also in Anabar with exception of only two species, *Entosthodon pulchellus* and *Fabronia ciliaris*.

The comments on these difference can be as follow. In addition to a better exploration, the Anabar Plateau has also a considerable difference in bedrock composition. Having rocks from acid to limestone (Fedosov et al., 2011), that area has, *e.g.*, 12 species of *Seligeria*, whereas Orulgan bryoflora has non. Permian to Triassic aleurolites are rather homogeneous in Orulgan, which reduces the composition not only on rocks theirselves, but also in mires, where we did not find, *e.g.*, *Pseudocalliergon trifarium* and *Paludella squarrosa,* a common species growing with *Scorpidium scorpioides* in other parts of Verkhoyansk Mountain system.

Two other interesting aspects of the Orulgan moss flora are worth mentioning. It has a good representation of Splachnaceae species, obviously caused by the reindeer farming. Although the number of species is not great, at least two of them, *Splachnum luteum* and *S. sphaericum* are quite common throughout the territory, being more common than in any other place where we personally collected bryophytes. *Tetraplodon mnioides* is common throughout the territory as well, but its abundance is not exceptional, and *T. paradoxus* is common in the mountain tundra belt (while it was rare in Anabar and not recorded in Yana-Adycha Plateau).

Mire composition is interesting by the abundance of rich fen species that are not very common in peatlands in the boreal forest zone in Russia. These mires are especially outstanding in the abundance of *Scorpidium scorpioides*. This species was not found in Yana-Adycha Plateau (Isakova, 2010), being known by just one collection in the southern part of Orulgan, at lake shore (Afonina & Perfiljeva, 1981). In the studied area, at lower elevation (locs. 1-3 in Fig. 1, cf. Fig. 2) it was found only once, in the mire surrounding a small lake, growing submerged near the lake shore, *i.e.*, like in other parts of Yakutia (Ignatova et al., 2011), as well as other regions of northern Russia.

In the upper course of the Tumara River the situation is different: the area over 20 km long and 5-7 km wide (cf. Fig. 1, localities 10-11 and to the east) is covered by communites of *Carex stans* and *Eriophorum polystachyon* (Fig. 10) where *Scorpidium scorpioides* is dominating in ground moss cover, being often the only moss over tens and hundreds of meters (Fig. 12), only occasionally associated with *Meesia triquetra* and *Scorpidium revolvens*. Small raisings of permafrost immediately provide a room for *Sphagnum* (Fig. 13), with admixture of *Polytrichum jensenii, Tomentypnum nitens, Aulacomnium spp., Warnstorfia sarmentosa, Campylium stellatum, Hylocomium splendens* var. *obtusifolium, etc*. More flooded places in depressions and along poorly developed brooks are surrounded by *Cinclidium arcticum, Scorpidium revolvens, Warnstorfia sarmentosa, Meesia triquetra, M. uliginosa, Philonotis tomentella*.

Such dominance of *Scorpidium scorpioides* allows drawing a parallel with periods when *Scorpidium*-peat was accumulated in large quantities, *e.g.*, in the Early Holocene in NW European Russia (Oksanen et al., 2003) or Middle Holocene of Quebec (Lamarre et al., 2012) and Alberta (Yu et al., 2003a,b). Later *Scorpidium* was substituted by *Sphagnum* or *Tomentypnum* peat. This change is usually associated with the autogenically induced drying trends, because *Scorpidium* is considered as a moss sensitive to drought (Kooijman & Whilde, 1993). This fact immediately draws a scenario where *Scorpidium* grows floating in shallow water-body or at least in system of hollows, because throughout ts range, *S. scorpioides* is most commonly submerged in such habitats.

The Tumara' population illustrates, however, a different possible habitat of the species. It grows here not in a lake or a pool, but is almost exposed to the air, at 24 hours a day sunshine during mid summer, and with very rare rain precipitation. The melting permafrost in combination with regular trampling by reindeers provides an environment where almost no other moss can compete with *S. scorpioides*. The mineral elements contents were not measured, however, they must be very high due to evaporation caused by strong winds, rather poor shading by grazed sedges and cotton-grasses, lack of precipitation (150-200 mm a year), and poor drainage. This interesting fen type should be studied in more detail as it likely represents a relic and almost extinct plant community. We can speculate, that similar communities served as a pasture for mammoth, being though poor, but anyway the most productive type of vegetation in this area (cf. Figs. 11, 14-17). Note that among mosses found with one of the best preserved mammoth body in Magadan area (Abramov & Abramova, 1981) 38 out of 40 moss taxa (identified partly to species, partly to genus level) were the same as in the Orulgan.

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